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COMPLETE SPECIFICATION

Golf Balls

We, POLYMER CORPORATION LIMITED, a company organized under the laws of Canada, of Sarnia, Ontario, Canada, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The is invention relates to golf balls.

Golf balls of the conventional type consist substantially of a rubbery core wound with elastic tape or thread and a cover, usually containing balata or a balata-like material, moulded to the wound core. The manufacture of durable golf balls of this type having good playing characteristics and a long playing life is, however, rather expensive.

It is, therefore, an object of the present invention to provide a golf ball which is cheaper to manufacture than a ball having a wound core, while possessing durability and playing characteristics comparable to those of the conventional ball.

According to the present invention, a golf ball consists essentially of a core comprising a cured synthetic *cis*-1,4 polymer of a conjugated diolefine and a synthetic *trans*-1,4 polymer of a conjugated diolefine, and an outer cover fixed to the core comprising a synthetic *trans*-1,4 polymer of a conjugated diolefine, the latter polymer having a *trans*-1,4 content of not less than 90 mole per cent.

The invention also includes a process of producing a golf ball which comprises the steps of forming the core by moulding, to the shape of a ball, a composition including a synthetic *cis*-1,4-polymer of a conjugated diolefine in a pre cured condition and a synthetic *trans*-1,4 polymer of a conjugated diolefine, moulding a cover composition containing a synthetic *trans*-1,4-polymer of a conjugated diolefine and having a *trans*-1,4 content of not less than 90 mole per cent, to form semi-spherical shells and fixing the shells to the core.

Suitable cores include those comprising from 10 to 80 parts by weight of the cured synthetic *cis*-1,4 polymer and from 90 to 20 parts by weight of the synthetic *trans*-1,4 polymer and especially those containing at least 50 parts by weight of the *cis*-1,4 polymer. Golf balls having optimum physical properties are, however, normally obtained from cores containing from 70 to 80 parts by weight of the cured *cis*-1,4 polymer.

While golf balls possessing wholly cured cores clearly fall within the ambit of the present invention, those with cores containing a cured *cis*-polymer and an uncured *trans*-1,4 polymer are preferred since they generally exhibit superior physical properties and, moreover, they require a greatly reduced curing time for their production.

Desirably, the golf balls of the present invention combine a Shore C hardness of at least 50, preferably from 60 to 70, and an impact resilience of at least 50 per cent, preferably from 60 to 75 per cent. Furthermore, a suitable weight ratio of outer cover to core has been found to be of the order of 1:5.

The golf ball cores can comprise synthetic *cis*-1,4 polymers possessing a *cis*-1,4 content as low as the minimum of 50 mole per cent, but it is preferred to employ those polymers having a *cis*-1,4 content of at least 90 mole per cent, while the *trans*-1,4 polymers of the cores preferably have a *trans* content of at least 80 mole per cent.

The conjugated diolefines from which the *cis*-1,4 and *trans*-1,4 polymers of the ball are prepared may be either unsubstituted or substituted, although *cis*-1,4 polymers derived from unsubstituted diolefines and *trans*-1,4 polymers derived from substituted diolefines containing up to eight carbon atoms in the molecule, have proved to be especially suitable. Typical examples of the unsubstituted conjugated diolefines are 1,3-butadiene and

piperylene. Of the substituted conjugated diolefines having not more than eight carbon atoms, the alkyl- and chloro- substituted dienes are particularly suitable, such as isoprene, 2,3 -

5 dimethyl - 1,3 - butadiene and chloroprene.

If desired, the outer cover can also include a minor proportion of a rubbery polymer. Rubberly polymers which have been found to be suitable for this purpose include natural rubber, polymers of substituted and unsubstituted conjugated diolefines such as 1,3 - butadiene, piperylene, isoprene, 2,3 - dimethyl - 1,3 - butadiene and chloroprene, copolymers of butadiene with styrene and acrylonitrile. As the rubbery polymer there can also be used polyurethanes and rubbery copolymers of ethylene with other α - olefines such as propylene or butene with or without diolefines, if desired.

The two semi-spherical shells constituting the outer cover of the golf ball can be fixed to the core in various ways, for example, by vulcanizing, fusing or adhering them to the core, although it is more usual to employ a vulcanization technique.

25 The conjugated diolefin polymers useful in the invention may be prepared according to any of the suitable methods known in the art. For example, the *trans* - 1,4 polymers may be prepared by polymerizing the appropriate monomer in solution in an inert solvent, in the presence of a catalyst comprising vanadium trichloride and an aluminium trialkyl. *Cis* - 1,4 polybutadiene may be prepared by polymerizing butadiene in solution in an inert solvent, in the presence of a catalyst comprising titanium tetraiodide and aluminium triisobutyl. *Cis* - 1,4 polyisoprene may be prepared by polymerizing isoprene in solution in an inert solvent, in the presence of a catalyst comprising titanium tetrachloride and aluminium triisobutyl.

In a convenient process of carrying out the invention, a synthetic *cis* - 1,4 polymer such as *cis* - 1,4 - polybutadiene, is heated under pressure in the presence of, preferably, an organic peroxide vulcanizing agent, for a predetermined time at the curing temperature, usually for approximately three-quarters of an hour at about 300°F, to form cured sheets which are ground to a powder in a mill. The cured powder is then intimately admixed with, for example, a *trans* - 1,4 polyisoprene and a suitable filler such as barium sulphate, to form a composition which is moulded to a sphere by heating in a mould for a few minutes at a temperature of from 200—300°F and a pressure of from 25,000 to 35,000 lbs. The resulting cores are subsequently removed from the mould after the latter has been cooled to room temperature while still under pressure.

The cover composition is prepared by compounding, for example, a *trans*-polyisoprene, on an open two-roll mill or in an internal mixer such as a Banbury mixer, with a minor proportion of, for example, a *cis* - 1,4 polybuta-

diene, together with a vulcanizing agent, a vulcanization accelerator, a filler and a pigment. Suitable pigments include white clays, calcium carbonate, silicas and titanium dioxide. The resulting stock is conveniently heated by immersion in boiling water for about ten minutes then is moulded into semi - spherical shells at room temperature.

To semi-spherical shells are placed around each core and the assemblies are normally cured for from 2 to 10 minutes at a temperature of from 200° to 350°F and a pressure of from 25,000 to 35,000 lbs. The balls so obtained comprise an outer cover vulcanized to a core containing unvulcanized *trans* - 1,4 polyisoprene.

In an alternative process, the core composition is prepared by compounding the precured *cis* - 1,4 polybutadiene, *trans* - 1,4 polyisoprene and filler together with a suitable vulcanizing agent and accelerator. When the shells are placed around their respective cores, the assemblies are generally cured for from one to two hours at a temperature of from 275° to 325°F and a pressure of from 25,000 to 35,000 lbs. In this case, the balls on removal from the mould comprise an outer cover vulcanized to a core containing a vulcanized *trans* - polyisoprene.

The balls produced according to these two processes are subsequently finished by cleaning, buffing, brushing, tumbling and painting in the usual manner.

If desired, the *cis* - 1,4 and *trans* - 1,4 polymers incorporated in the outer cover may correspond to those used in the core.

A wide variety of fillers are suitable for use in the core of the ball, typical examples being, apart from barytes, lithopone (70% zinc sulphide and 30% barium sulphate), titanium dioxide, zinc oxide, iron filings, lead filings and litharge.

By utilizing synthetic *cis* - 1,4 and *trans* - polymers of the kind referred to above, it has been possible to depart from the structure of the conventional ball, thereby enabling the time and labour normally spent on golf ball manufacture to be considerably reduced while still producing a ball having good durability and playing characteristics.

The invention will now be illustrated by the following Examples, all parts being by weight:—

EXAMPLE I

One hundred parts of a synthetic *cis* - 1,4 polybutadiene having a *cis* - 1,4 content of 97 mole per cent and a Mooney viscosity of 45 was mixed with 2.5 parts of dicumyl peroxide and cured in a hydraulic press for forty minutes at 293°F, the product being obtained in the form of 0.125 inch sheets. The cured sheet material was then reduced to a powder by passage through a mill adjusted to a tight roll setting.

5 A core composition was prepared by compounding, on a mill at 212°F, the powdered *cis* - 1,4 polybutadiene with a synthetic *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of 90 mole per cent and a Mooney viscosity of 35, and barytes in the following proportions:—

Trans - 1,4 polyisoprene 25 parts
Cis - 1,4 polybutadiene 75 "
 Barytes 25 "

10 The core composition was moulded into balls of 1.55 inch diameter by heating in a ball mould for 5 minutes at 250°F under a pressure of 30,000 lbs. The mould was allowed to cool to room temperature while still under pressure and the moulded cores were removed.

15 A cover composition was prepared by compounding a synthetic *trans* - 1,4 polyisoprene and a synthetic *cis* - 1,4 polybutadiene similar to those used in making the core composition, with vulcanizing ingredients in the following proportions:—

20 *Trans* - 1,4 polyisoprene 100 parts
Cis - 1,4 polybutadiene 6.25 "
 25 Sulphur 2.62 "
 Zinc oxide 6.5 "
 Stearic acid 0.265 "
 Titanium dioxide 15 "
 Benzothiazyl disulphide 1 part

The resulting stock was immersed in water at 212°F for ten minutes and then moulded into half shells at room temperature. Around each moulded core comprising cured *cis*-1,4 polybutadiene and uncured *trans* - 1,4 polyisoprene, were placed two of the half shells which were cured to the core for 5 minutes at 250°F under a pressure of 30,000 lbs. and the resulting balls were allowed to cool under the same pressure.

40 A second core composition was prepared as described above but incorporating, in addition, vulcanizing ingredients, namely 4 parts of sulphur and one part of benzothiazyl disulphide. On applying the half shells to cores moulded from this composition, the assemblies were cured for 90 minutes at 307°F under a pressure of 30,000 lbs. and allowed to cool at this pressure.

50 Physical tests were carried out on both types of ball, the results being shown in Table I below, where A denotes the ball submitted to the five minute cure and B denotes the ball submitted to the ninety minute cure.

TABLE I

Ball	Click Rating	Impact Resilience (% Rebound)	Cut Resistance
A	Similar to top grade commercial ball	68	No cut through cover, but dent 0.75 inch long, 0.02 inch deep and 0.10 inch wide
B	Quite good	68	No cut through cover, but dent 1.15 inch long, 0.10 inch wide and 0.05 inch deep

60 The impact resilience, expressed as percentage rebound, was determined by dropping a ball from a height of 38 inches on to a brass plate one inch thick and recording the height of the bound of the ball. The cut resistance was assessed by allowing a blade with a 20° knife edge and weighing ten pounds to be dropped on to the centre of a ball from a height of one foot. Click rating was assessed by dropping the balls from a height of about 65 5 feet on to a cement floor. Balls having a poor click emit a dull sound similar to that obtained from an ordinary rubber ball. Balls having the desired click, namely a good click,

70 emit a sound similar to that of a wooden ball, while balls having a fair click give rise to a sound between those obtained from poor and good click rated balls. A ball having a sharp click emits a sound which is too high in pitch, resembling that given by a glass bead.

75 While both balls possessed satisfactory impact resilience, click rating and cut resistance properties, ball A was preferred since it only required a curing time of five minutes as compared with 90 minutes for ball B and, moreover, exhibited a somewhat superior click rating and cut resistance. Both balls were found to have normal flight characteristics.

80

EXAMPLE II
A number of core compositions were prepared in the manner described for ball A in

Example I according to the following recipes:—

5

Core Composition	C	D	E	F	G
<i>Trans</i> -1,4-polyisoprene (parts)	90	80	60	40	20
<i>Cis</i> -1,4-polybutadiene (parts)	10	20	40	60	80
Barytes	30	30	30	30	30

10 The moulded cores and half shells were made as indicated in the previous Example and after applying the half shells to the cores, the former were cured to the latter in a mould for 3 minutes at 307°F under a pressure of 30,000 lbs. and the moulded balls subsequently

cooled while maintaining the same pressure, prior to removal from the mould.

Physical tests were carried out on the 15 various balls and moulded cores derived from compositions C, D, E, F and G, the results being shown in Table II below.

TABLE II

Core Composition	C	D	E	F	G
Impact Resilience (Core) (% Rebound)	60	60	60	57	70
Click Rating (Core)	Very Sharp	Very Sharp	Sharp	Normal	Fair
Impact Resilience (Ball) (% Rebound)	57.0	57.0	60.0	62.5	68.0
Click Rating (Ball)	Very Sharp	Very Sharp	Very Sharp	Good	Fair
Shore C Hardness (Ball)	80.0	80.0	78.0	70.0	65.0
Cut Resistance (Ball)	No cut	No cut	No cut	No cut	Slight cut

20 The physical properties of these balls coupled with their flight characteristics, make the balls an attractive proposition for driving range use, while the all-round characteristics of balls F and G are comparable with those
25 of a top grade commercial ball.

balls using ingredients in the same proportions and similar reaction conditions to those specified for ball A in Example I, except that the polybutadienes were cured at 307°F and the amount of barytes used was increased to 30 parts. 30

EXAMPLE III
Four different synthetic *cis* - 1,4 polybutadienes were employed to prepare moulded golf

Physical tests were carried out on the various 35 balls and moulded cores derived from core compositions H, I, J and K, the results being shown in Table III below.

TABLE III

Core Composition	H	I	J	K
Impact Resilience (Core) (% Rebound)	64.1	69.2	57.7	51.3
Impact Resilience (Ball) (% Rebound)	61.5	66.6	59.0	52.6
Click Rating (Ball)	Quite good	Good	Fair	Sharp
Cut Resistance (Ball)	Cut 0.5 inch long just through cover	No cut	Cut 0.25 inch long just through cover	No cut
Shore C Hardness (Ball)	61.0	63.0	67.0	65.0

- 5 The polybutadiene of composition H had a *cis* - 1,4 content of 93% and a Mooney viscosity of 45 (ML—4 at 212°F), the polybutadiene of composition I had a *cis* - 1,4 content of 97% and a Mooney viscosity of 45 (ML—4 at 212°F), the polybutadiene of composition J had a similar *cis* - 1,4 content and Mooney viscosity to that of composition I but
- 10 had been prepared by a different polymerization process, and the polybutadiene of composition K had a *cis* - 1,4 -content of 35% and a Mooney viscosity of 55 (ML—4 at 212°F).
- 15 With the possible exception of the ball prepared from composition K, which did not contain a true *cis* - 1,4 polybutadiene, all the balls would find considerable application in driving ranges, the composition I ball comparing most
- 20 favourably with a top grade commercial ball.

EXAMPLE IV

Five golf balls were prepared using the same ingredients, in the same proportions and the same reaction conditions as specified for ball A in Example I, except that the *cis* - 1,4 polybutadiene was cured at 307°F, each core composition contained 30 parts of a different filler and the shells were cured to the cores for 3 minutes at 307°F under a pressure of 30,000 lbs.

Physical tests were carried out on the various balls and moulded cores derived from core compositions L, M, N, O and P which contained, as fillers, lithopone (70% zinc sulphide and 30% barium sulphate), titanium dioxide, zinc oxide, iron filings and barytes respectively. The results of these tests are shown in Table IV below.

TABLE IV

Core Composition	L	M	N	O	P
Impact Resilience (Core) (% Rebound)	64.1	65.4	68.0	74.4	68.0
Impact Resilience (Ball) (% Rebound)	64.1	64.1	66.6	73.1	65.4
Click Rating (Ball)	Fair	Quite Good	Good	Good	Good
Cut Resistance (Ball)	No cut	Two cracks one inch long	No cut, but dent 1 inch long	No cut	No cut
Shore C Hardness (Ball)	70	60	70	69	69

The physical properties and flight characteristics of all these balls were found to compare most favourably with those of a top grade commercial ball, the results obtained with the ball derived from composition O, which contained iron filings, being particularly impressive.

EXAMPLE V

Two golf balls were prepared using the same proportions of the same ingredients under the same reaction conditions as specified for

ball A in Example I, except that each core composition contained 30 parts of a different filler, the core compositions were moulded for 3 minutes at 250°F under a pressure of 30,000 lbs. and the shells were cured to the cores for 3 minutes at 293°F.

Physical tests were carried out on the two balls and moulded covers derived from core compositions Q and R which contained, as fillers, lead filings and litharge respectively. The results of these tests are shown in Table V below.

TABLE V

Core Composition	Q	R
Impact Resilience (Core) (% Rebound)	72	66.5
Impact Resilience (Ball) (% Rebound)	71.8	69.5
Click Rating (Ball)	Good	Good
Cut Resistance (Ball)	No cut, but dent 1.30 inch long and 0.02 inch deep	No cut, but dent 1.25 inch long
Shore C Hardness (Core)	45.0	45.0
Shore C Hardness (Ball)	60	70.0

The physical properties and flight characteristics of these two balls were most impressive, comparing favourably with those of a top grade commercial ball.

EXAMPLE VI

A cover composition was prepared by compounding a *trans* - 1,4 polychloroprene having a *trans* - 1,4 content of 95 mole per cent and a Mooney viscosity of 25 (ML—2.5 at 212°F) and a minor proportion of a copolymer of butadiene and styrene with various vulcanizing agents in the following amounts:—

<i>Trans</i> - 1,4 polychloroprene	100 parts
Butadiene/Styrene copolymer	15 "
Magnesia	2 "
Titanium dioxide	10 "
Zinc oxide	15 "
Antioxidant	1 "
Sulphur	1 "
Accelerator	1 "

The accelerator used was 5 - piperidium pentamethylene dithiocarbamate and the antioxidant was 2,6 - ditertiary - butyl - 4 - methyl phenol. The butadiene/styrene copolymer was a blend of 60 parts by weight of a butadiene/styrene copolymer having a mean hydrocarbon content of 94.1 per cent by weight

and a mean bound styrene content of 89.4 per cent by weight, and 40 parts by weight of a butadiene/styrene copolymer containing 28% by weight of bound styrene.

The polychloroprene was first banded on a two-roll mill, the rolls of which were heated to 180°F. When the polymer had been smoothed out into a sheet free from holes, the butadiene/styrene copolymer was added and mixed with the polymer. The resulting stock was removed as a sheet and allowed to cool. The mill was cooled to 120°F, the stock reintroduced thereto and the magnesia, titanium dioxide and antioxidant were added followed by zinc oxide, sulphur and accelerator, the latter being added quickly in order to avoid scorching. The compound was then rolled and end passed quickly six times with the mill at a tight setting; this procedure involved cutting off the compound from the mill, rolling the material into a cigar-like shape and introducing the end of the "cigar" between the rolls. In this way, the direction of mixing was changed and by repeating the operation six times, the blending was rendered more complete. Finally, the blend was sheeted off at a thickness of 0.25 inch.

A second cover composition was prepared by compounding a synthetic *trans* - 1,4 polyisoprene, having a Mooney viscosity of 30 (ML—4 at 212°F), and a minor proportion of

a smoked sheet natural rubber together with various vulcanizing agents in the following amounts:—

	<i>Trans</i> - 1,4 polyisoprene	100 parts
5	Smoked sheet natural rubber	15 "
	Titanium dioxide	10 "
	Zinc oxide	5 "
	Sulphur	1.5 "
	Accelerator	1 "

10 The *trans* - 1,4 polyisoprene was first banded on a two roll mill, the rolls of which were heated at 170°F. When the polymer had smoothed out on the rolls into a hole-free sheet, the smoked sheet natural rubber was added and blended into the polymer. The resulting stock was removed as a sheet and allowed to cool. The mill was then cooled to 150°F, the stock reintroduced between the rolls and titanium dioxide added followed by sulphur, zinc oxide and accelerator (the same as used for the first cover composition). The compound was rolled and end passed six times with the mill at a tight setting, prior to being finally removed as a sheet.

25 A third cover composition was prepared by compounding the synthetic *trans* - 1,4 polyisoprene used for the second cover composition with minor proportions of smoked sheet natural rubber and a copolymer of butadiene and styrene, together with various vulcanizing agents in the following amounts:—

	<i>Trans</i> - 1,4 polyisoprene	100 parts
	Smoked sheet natural rubber	10 "
	Butadiene/styrene copolymer	20 "
35	Titanium dioxide	15 "
	Zinc oxide	5 "
	Sulphur	1.5 "
	Accelerator	1 part

40 The butadiene/styrene copolymer was a blend of 44 parts of a butadiene/styrene co-

polymer having a mean hydrocarbon content of 94.1 per cent by weight and a mean bound styrene content of 89.4 per cent by weight, and 56 parts by weight of a butadiene/styrene copolymer containing 28 per cent by weight of bound styrene.

The *trans* - 1,4 polyisoprene was first banded on a roll mill having two rolls heated to 180°F. When the polymer had smoothed out into a hole-free sheet, the butadiene/styrene copolymer and smoked sheet natural rubber were added and on obtaining a smooth mix, the titanium dioxide was incorporated. The resulting stock was removed as a sheet and allowed to cool. The mill was then cooled to 150°F, the stock reintroduced thereto and the zinc oxide, sulphur and accelerator (same as used for the other two cover compositions) were added. The ingredients were thoroughly blended into the mix by rolling and end passing the stock six times with the rolls at a tight setting and then the compound was removed as a sheet.

The resulting sheeted stocks of each of the three cover compositions were immersed in water at 212°F for ten minutes prior to being moulded into half shells at room temperature.

A core composition was prepared in the same manner and having the same ingredients in the same proportions as composition Q of Example V. After moulding the core composition for 3 minutes at 250°F under a pressure of 30,000 lbs. to form 1.55 inch diameter balls, half shells of each of the three cover compositions were applied to respective cores. The assemblies were cured for three minutes at 293°F under 30,000 lbs. pressure in a golf ball mould and subsequently allowed to cool while still under pressure.

Physical tests were carried out on the three types of ball, the results being shown in Table VI below, where S, T and U denote the first, second and third compositions with which the common cores were covered.

TABLE VI

Cover Composition	S	T	U
Impact Resilience (% Rebound)	69.2	71.8	71.8
Click Rating	Fair	Fair	Quite Good
Cut Resistance	Cut just through cover, 1.25 inch long	Cut just through cover, 1.00 inch long	Cut just through 0.25 inch long
Shore C Hardness	52.0	52.0	59.0

The physical properties and flight characteristics of all these balls were at least good enough to render them suitable for driving range use.

5 EXAMPLE VII

A powdered cured synthetic *cis* - 1,4 polybutadiene was prepared from the same raw polymer and in the same manner as described in Example I.

10 A core composition was prepared by compounding the powdered *cis* - 1,4 polybutadiene with a synthetic *trans* - 1,4 polychloroprene having a *trans* - 1,4 content of 95 mole per cent and a Mooney viscosity of 25 (ML—2.5 at 212°F), and litharge in the following proportions:—

<i>Trans</i> - 1,4 polychloroprene	25 parts
<i>Cis</i> - 1,4 polybutadiene	75 "
Litharge	30 "

20 The *trans* - 1,4 polychloroprene was banded on a two-roll mill, the rolls of which were heated to 180°F. The *cis* - 1,4 polybutadiene and litharge were added and after thorough mixing, the compound was folded and passed

25 between the rollers six times at a tight setting. A second core composition was prepared by compounding the components of the above composition along with vulcanizing ingredients in the following proportions:—

30 <i>Trans</i> - 1,4 polychloroprene	25	parts
<i>Cis</i> - 1,4 polybutadiene	75	"
Litharge	30	"
Sulphur	0.25	"
Accelerator	0.175	"

The accelerator used was 5 - piperidium pentamethylene dithio carbamate. 35

The *trans* - 1,4 polychloroprene was banded on the mill having rolls heated to 180°F and the *cis* - 1,4 polybutadiene and litharge were mixed in as described above. At this stage, 40 the mix was sheeted off from the mill and allowed to cool while the temperature of the rolls was lowered to 150°F. The mix was then reintroduced on the mill and the sulphur and accelerator were blended into it. In order 45 to ensure good mixing, the compound was folded and passed between the rolls at a tight setting six times.

The first core composition was moulded into balls of 1.55 inch diameter by heating in a ball mould for 5 minutes at 250°F under a pressure of 30,000 lbs. The mould was allowed to cool to room temperature while still under pressure and the moulded cores were removed 50 and left to stand for 16 hours at 77°F before testing. 55

Moulded cores of similar size were made using the second core composition but, in this case, heating was carried out for 20 minutes at 307°F so that the cores were wholly cured 60 and they were removed from the mould hot.

Both types of 1.55 inch diameter ball were covered by applying half shells of the same composition as used in Example I, heating the assemblies for 3 minutes at 250°F under a pressure of 30,000 lbs. and allowing the resulting balls to cool to room temperature at the same pressure. 65

Physical tests were carried out on the two types of ball and moulded core, the results 70 being shown in Table VII below; where V and U denote the first core composition and second core composition respectively.

TABLE VII

Core Composition	V	U
Impact Resilience (Core) (% Rebound)	69.2	69.2
Click Rating (Core)	Rather poor	Poor
Cut Resistance (Core)	Cut 0.45 inch deep 1.5 inch long	Cut 0.3 inch deep 1.6 inch long
Shore C Hardness (Core)	50	50
Impact Resilience (Ball) (% Rebound)	69.2	73.2
Click Rating (Ball)	Fair	Rather poor
Cut Resistance (Ball)	No cut, dent 1.4 inch long, 0.02 inch deep	No cut, dent 1.5 inch long, 0.08 inch deep
Shore C Hardness (Ball)	57.0	56.0

The physical properties and flight characteristics of these balls were at least good enough to render them suitable for driving range use.

5 EXAMPLE VIII

One hundred parts of a synthetic *cis* - 1,4 polybutadiene having a *cis* - 1,4 content of 97 mole per cent and a Mooney viscosity of 45 was mixed with 2.5 parts of dicumyl peroxide and cured in a hydraulic press for forty minutes at 293°F, the product being obtained in 0.125 inch sheets. The cured sheet material was then reduced to a powder by passage through a mill adjusted to a tight roll setting. A core composition was prepared by compounding, on a mill at 212°F, the powdered *cis* - 1,4 polybutadiene with a synthetic *trans* - 1,4 - polyisoprene having a *trans* - 1,4 content of 90 mole per cent and a Mooney viscosity of 35, and litharge in the following proportions:—

<i>Trans</i> - 1,4 polyisoprene	25 parts
<i>Cis</i> - 1,4 polybutadiene	75 "
Litharge	30 "

The core composition was moulded into balls of 1.55 inch diameter by heating in a ball mould for 5 minutes at 250°F under a pressure of 30,000 lbs. The mould was allowed to cool to room temperature while still under pressure and the moulded cores were removed.

A cover composition was prepared by compounding a synthetic *trans* - 1,4 polyisoprene and a synthetic *cis* - 1,4 polybutadiene similar to those used in making the core composition with titanium dioxide in the following proportions:—

<i>Trans</i> - 1,4 polyisoprene	100 parts
<i>Cis</i> - 1,4 polybutadiene	6.25 "
Titanium dioxide	15 "

The resulting stock was immersed in water at 212°F for ten minutes and then moulded into half shells at room temperature. Around each moulded core were placed two of the half shells and the latter were fused to their respective cores by heating the assemblies for

one minute at 250°F under a pressure of 30,000 lbs. and then the resulting balls were allowed to cool gradually for 20 minutes at this pressure.

Physical tests were carried out on one of the balls which was found to have a good click rating, an impact resilience (% rebound) of 68 and a Shore C hardness of 66. On testing cut resistance, there was no cut through the cover, but a dent 1.35 inches long and 0.05 inch wide. The ball also exhibited normal flight characteristics.

EXAMPLE IX

Blends were prepared by mixing on a mill for 10 minutes, a synthetic *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of 90 mole per cent and a Mooney viscosity of 20 with each of the following polymers: a neoprene having a Mooney viscosity of 25; a *trans* - 1,4 polybutadiene having an intrinsic viscosity in toluene at 30°C of 3.4; an amorphous copolymer of ethylene and propylene (EPM) containing 48 mole % ethylene and having a Mooney viscosity of 40; and an amorphous copolymer of ethylene, propylene and dicyclopentadiene (EPDM) containing 68.2 mole % ethylene, 3.2 mole % dicyclopentadiene and having a Mooney viscosity of 65.

Core compositions were prepared by mixing 25 parts of each of the above blends with 75 parts of a powdered cured synthetic *cis* - 1,4 polybutadiene prepared from the same polymer and in the same manner as described in Example I. The mixtures were moulded into balls of 1.55 inches in diameter by heating in a mould for five minutes at 300°F under a pressure of 30,000 lbs.

Cover compositions were prepared by moulding each of the above blends into half shells at room temperature. Around each of the moulded cores were placed two half shells prepared from the same blend as used in the core. The shells were then fused to their respective cores by heating the assemblies for one minute at 300°F under a pressure of 30,000 lbs. and then allowing the resulting balls to cool gradually for 20 minutes at this pressure. The Impact Resilience and Shore C hardness were determined on each ball, the results being shown in Table VIII.

Ball Number	TABLE VIII					
	1	2	3	4	5	6
Blend Composition (parts by weight)						
Trans-1,4-polyisoprene	75	25	75	25	80	80
Neoprene	25	75	—	—	—	—
Trans-1,4-polybutadiene	—	—	25	75	—	—
EPM	—	—	—	—	20	—
EPDM	—	—	—	—	—	20
Blending Temp. (°F.)	235	230	235	330	235	235
Impact Resilience (% Rebound)	70.5	71.8	65.4	67.4	70.2	69.2
Shore C Hardness	68.0	62.2	70.0	68.0	52.0	53.0

- The balls were found to have a satisfactory click rating. The cut resistance in each case was found to be excellent and the balls exhibited normal flight characteristics.
- Where the term "pressure" has been used in this specification, it is the gage reading of a PHI hydraulic press Model P—215, manufactured by Pasadena Hydraulics Incorporated, California, U.S.A.
- WHAT WE CLAIM IS:—
1. A golf ball consisting essentially of a core comprising a cured synthetic *cis* - 1,4 polymer of a conjugated diolefine and a synthetic *trans* - 1,4 polymer of a conjugated diolefine, and an outer cover fixed to the core and comprising a synthetic *trans*-1,4 polymer of conjugated diolefine, the latter polymer having a *trans* - 1,4 content of not less than 90 mole per cent.
 2. A golf ball according to Claim 1, wherein the core comprises 10 to 80 parts by weight of the cured synthetic *cis* - 1,4 polymer and 90 to 20 parts by weight of the synthetic *trans* - 1,4 polymer.
 3. A golf ball according to Claim 1, wherein the core comprises 10 to 80 parts by weight of the cured synthetic *cis* - 1,4 polymer and 90 to 20 parts by weight of the synthetic *trans* - 1,4 polymer in an uncured condition.
 4. A golf ball according to Claim 1, 2 or 3 wherein the core contains at least 50 parts by weight of the synthetic *cis* - 1,4 polymer.
 5. A golf ball according to any of the previous claims, wherein the core contains from 70 to 80 parts by weight of the synthetic *cis* - 1,4 polymer.
 6. A golf ball according to any of the previous claims, wherein the synthetic *cis* - 1,4 polymer has a *cis* - 1,4 content of at least 90 mole per cent.
 7. A golf ball according to any of the previous claims, wherein the synthetic *trans* - 1,4 polymer of the core has a *trans* - 1,4 content of at least 80 per cent.
 8. A golf ball according to any of the previous claims, wherein the core comprises a cured synthetic *cis* - 1,4 polymer of an unsubstituted conjugated diolefine having 4 to 8 carbon atoms.
 9. A golf ball according to any of the previous claims, wherein the synthetic *trans* - 1,4 polymer is a polymer of a substituted conjugated diolefine containing up to eight carbon atoms in the molecule.
 10. A golf ball according to any of the preceding claims, wherein the core also contains an inorganic filler.
 11. A golf ball according to Claims 1 to 10, wherein the weight ratio of the outer cover is of the order of 1:5.
 12. A golf ball according to any of Claims 1 to 11, having an impact resilience of at least 50 per cent and a Shore C hardness of at least 50.
 13. A golf ball according to any of Claims 1 to 11, having an impact resilience of from 60 to 75 per cent and a Shore C hardness of from 60 to 70.
 14. A golf ball according to any of Claims 1 to 13, wherein the outer cover also comprises a minor proportion of a rubbery hydrocarbon.
 15. A golf ball according to Claim 14, wherein the outer cover also comprises a minor proportion of a rubbery polymer selected from the group consisting of natural rubber, polymers of substituted and unsubstituted con-

- jugated diolefines, copolymers of ethylene with at least one other olefinic compound, copolymers of butadiene and styrene and mixtures thereof.
- 5 16. A golf ball according to any of Claims 1 to 14, wherein the outer cover also comprises from 3 to 6 per cent of a synthetic *cis* - 1,4 polybutadiene based on the weight of the said cover.
- 10 17. A golf ball according to any of the preceding claims, wherein the synthetic *trans* - 1,4 polymer of the outer cover is a polymer selected from the group consisting of *trans* - 1,4 polyisoprene and *trans* - 1,4 polychloroprene.
- 15 18. A golf ball according to any of Claims 1 to 17, wherein the core comprises an unsynthetic *trans* - 1,4 - polychloroprene and a cured synthetic *cis* - 1,4 polybutadiene.
- 20 19. A golf ball according to any of Claims 1 to 17, wherein the core comprises a cured synthetic *trans* - 1,4 polyisoprene and a cured synthetic *cis* - 1,4 polybutadiene.
- 25 20. A golf ball according to any of Claims 1 to 17, wherein the core comprises an uncured synthetic *trans* - 1,4 polychloroprene and cured synthetic *cis* - 1,4 polybutadiene.
- 30 21. A golf ball according to any of Claims 1 to 17, wherein the core comprises a cured synthetic *trans* - 1,4 polychloroprene and a cured synthetic *cis* - 1,4 polybutadiene.
- 35 22. A golf ball consisting essentially of a core comprising from 70 to 80 parts by weight of a cured synthetic *cis* - 1,4 polybutadiene having a *cis* content of at least 90 mole per cent and from 30 to 20 parts by weight of an uncured synthetic *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of at least 80 mole per cent, and an outer cover fixed to the core and comprising at least 70 per cent by weight of a synthetic *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of not less than 90 mole per cent, said ball having a Shore C hardness of up to 70 and an impact resilience of up to 75 per cent.
- 45 23. A golf ball consisting essentially of a core comprising about 75 parts by weight of a cured synthetic *cis* - 1,4 polybutadiene having a *cis* - 1,4 content of not less than 90 mole per cent, about 25 parts by weight of an uncured *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of at least 80 mole per cent and about 30 parts of an inorganic filler selected from the group consisting of iron filings, lead filings, litharge, zinc oxide, barium sulphate and lithopone; and an outer cover vulcanized to the core and comprising at least 70 per cent by weight of cured synthetic *trans* - 1,4 polyisoprene having a *trans* - 1,4 content of not less than 90 mole per cent and from 3 to 6 per cent by weight of cured synthetic *cis* - 1,4 polybutadiene, said ball having a Shore C hardness of from 60 to 70 and an impact resilience of from 60 to 75 per cent.
- 60 24. A process for the production of a golf ball of the kind claimed in Claim 1, which comprises the steps of forming the core by moulding, to the shape of a ball, a composition including a synthetic *cis* - 1,4 polymer of a conjugated diolefine in a precured condition and a synthetic *trans* - 1,4 polymer of a conjugated diolefine, moulding a cover composition containing a synthetic *trans* - 1,4 polymer of a conjugated diolefine and having a *trans* - 1,4 content of not less than 90 mole per cent, to form semi-spherical shells, and fixing the shells to the core.
- 65 25. A process according to Claim 24, wherein the core-forming composition is prepared by precuring the synthetic *cis* - 1,4 polymer using an organic peroxide vulcanizing agent, reducing the product to a powder and intimately admixing the powder with the synthetic *trans* - 1,4 polymer.
- 70 26. A process according to Claim 24 or 25, wherein the cover composition is vulcanizable and the shells formed therefrom are fixed to the core by vulcanization under pressure at an elevated curing temperature.
- 75 27. A process according to Claim 26, wherein vulcanization of the shells to the core is effected by applying a temperature of from 200 to 350°F for two to ten minutes.
- 80 28. A process according to Claim 26, wherein the shells are fixed to the core by fusion under pressure at an elevated temperature.
- 85 29. A process according to any of Claims 24 to 28, wherein an inorganic filler selected from the group consisting of iron filings, lead filings, litharge, zinc oxide, barium sulphate and lithopone is included in the core-forming composition.
- 90 30. A process according to Claims 24 to 27, wherein the core-forming composition incorporates a vulcanizing agent enabling the synthetic *trans* - 1,4 polymer of said composition to be vulcanized at the same time as the semi-spherical shells.
- 95 31. A process for the production of a golf ball substantially as described herein with particular reference to the foregoing examples.
- 100 32. Golf balls whenever produced by a process according to any of Claims 24 to 31.
- 105 110

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